

**From:** <jgiel@babcockpower.com>  
**To:** <kenneth-n@ipsc.com>  
**CC:** <fpalacios@babcockpower.com>  
**Date:** 2/3/2004 2:35 PM  
**Subject:** Fw: 100221-IP2-Test Port Location  
**Attachments:** Test-Port-Location.dwg; Test-Port-Location.dwg

Ken:

Attached is a drawing showing the location of the test ports.  
There are two (2) locations shown, O's and X's.  
Which location do you prefer?

(See attached file: Test-Port-Location.dwg)

Regards

Jerry

----- Forwarded by Jerry Giel@babcockpower on 02/03/2004 11:47 AM -----

Jerry  
Giel@babcockpower  
er  
02/03/2004 10:52 AM  
To  
phil-h@ipsc.com, jim-n@ipsc.com  
cc  
Larry  
Wise/babcockpower@babcockpower,  
Larry  
Boucher/babcockpower@babcockpower  
Subject  
100221-IP2-Test Port Location

Phil:

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There are two (2) locations shown, O's and X's.  
Which location do you prefer?

(See attached file: Test-Port-Location.dwg)

Please respond ASAP.

Thanks

IP7\_039959

Jerry

\*\*\*\*\*

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\*\*\*\*\*

**From:** Ken Nielson  
**To:** Jon Christensen  
**Date:** 10/1/2003 7:41 AM  
**Subject:** Fwd: Intermountain Power - Unit 2 OFA controls design information  
**Attachments:** Intermountain Power - Unit 2 OFA controls design information

Jon,

The attached e-mail is the note I sent to the Babcock Power requesting information on any modifications to the controls for U2 OFA. As yet we have not received anything on this.

**From:** <fpalacios@bbpwr.com>  
**To:** <KENNETH-N@ipsc.com>  
**CC:** <BILL-M@ipsc.com>, <Jerry-F@ipsc.com>, <JIM-N@ipsc.com>, <ddorman@bbpwr....>  
**Date:** 1/3/2003 12:15 PM  
**Subject:** Re: Intermountain Power. Contract 100210 - Overfire air systemcontrols  
**Attachments:** OFA Control Description Rev1.doc

Ken:

According to your call of today, I have talked to Larry Boucher and to the mechanical design group and we are in agreement to keep the balancing dampers to be operated remotely by Jordan electrical damper drives as per original supply. Again we recommend that these dampers be used to balance the ducts and left in the "as balanced" position and be returned to that position after any other movement that you may occasionally subject them to, as during emergencies, etc.

Please find attached Revision 1 of the "Control of Overfire Air" document, which revises the operation of these dampers from local manual to remote electrical.

(See attached file: OFA Control Description Rev1.doc)

\*\*\*\*\*

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\*\*\*\*\*

**From:** James Nelson  
**To:** Ken Nielson  
**Date:** 4/9/2003 11:26 AM  
**Subject:** Fwd: New Jordan Actuator IPSC

Is there a reason we need to go through BPI?

>>> <loucher@bbpwr.com> 04/09/03 09:18AM >>>

Riley Power (BPI) is please to offer for your consideration our firm price of four thousand eight hundred dollars, (\$4,800.00) for a spare Jordan Actuator, model SM-5120-N-29/300-D001-F001.

Pricing is firm for thirty (30) days , FOB job site and includes freight.

Delivery is approximately four (4) weeks, however RPI will expedite this as much as possible in an attempt to improve delivery.

I trust this information meets your current needs. Please let me know how IPSC would like to proceed.

Regards

Larry

\*\*\*\*\*

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\*\*\*\*\*

IP7\_039963

**From:** Ken Nielson  
**To:** Dean Wood  
**Date:** 5/5/2003 1:26 PM  
**Subject:** Fwd: OFA Eyebrows  
**Attachments:** OFA Eyebrows

Dean,  
Attached are the e-copies of Phil's photos of the port with and without eyebrows.

IP7\_039964

**From:** James Nelson  
**To:** Ken Nielson  
**Date:** 2/4/2004 3:35 PM  
**Subject:** Fwd: Re: Fw: 100221-IP2-Test Port Location

Please stop by Phil's office for a discussion on test ports if you haven't seen the most recent email from Sal. ths

>>> Ken Nielson 2/3/2004 5:07:32 PM >>>

Jerry,

I am concerned that both locations will have excessive problems with turbulent flow. The "X" locations are immediately downstream of the OFA feeder dampers. The "O" locations are at a point where the OFA feeder duct is converging. These, plus the closer proximity to the elbow from the supply header to the feeder duct will likely mean excessive turbulence at both locations and greater problems getting good test measurements. On Unit 1, we found extreme stratification in the flows even at a point further downstream. Without turning vanes, I think we would find it worse at the and "O" locations.

Please look at a location further downstream in the feeder duct where turbulence would be minimized and the flow profile is the same as Air Monitor volu-probes. As you did with the locations suggested above, please look for any problems we might have with boiler area structural steel blocking access to the ports with the long test probes. On Unit 1, we encountered some problems with that type of interference and had to relocate the ports.

Thank you for your efforts on this. Please let me know if you have questions this request.

Ken Nielson

Kenneth M. Nielson, P.E.  
Lead Engineer, Technical Services  
Intermountain Power  
Delta, UT 84624  
Phone: (435) 864-6437  
Fax: (435) 864-0737  
[kenneth-n@ipsc.com](mailto:kenneth-n@ipsc.com)

>>> <[jjielda@babcockpower.com](mailto:jjielda@babcockpower.com)> 2/3/2004 9:49:48 AM >>>

Ken:

Attached is a drawing showing the location of the test ports.  
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Which location do you prefer?

(See attached file: Test-Port-Location.dwg)

Regards

Jerry

----- Forwarded by Jerry Gielda/babcockpower on 02/03/2004 11:47 AM -----

IP7\_039965

Jerry  
Gielda/babcockpower  
er  
To  
[phil-h@ipsc.com](mailto:phil-h@ipsc.com), [jim-n@ipsc.com](mailto:jim-n@ipsc.com)  
02/03/2004 10:52 AM cc  
Larry  
Wise/babcockpower@babcockpower,  
Larry  
Boucher/babcockpower@babcockpower  
Subject  
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**From:** Ken Nielson  
**To:** James Nelson; Jon Christensen  
**Date:** 2/3/2004 5:07 PM  
**Subject:** Fwd: Re: Fw: 100221-IP2-Test Port Location

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Ken Nielson

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Intermountain Power  
Delta, UT 84624  
Phone: (435) 864-6437  
Fax: (435) 864-0737  
[kenneth-n@ipsc.com](mailto:kenneth-n@ipsc.com)

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Regards

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----- Forwarded by Jerry Gielda/babcockpower on 02/03/2004 11:47 AM -----

Jerry  
Gielda/babcockpow  
er  
To  
[phil-h@ipsc.com](mailto:phil-h@ipsc.com), [jim-n@ipsc.com](mailto:jim-n@ipsc.com)

IP7\_039967

02/03/2004 10:52 AM cc  
Larry  
Wise/babcockpower@babcockpower,  
Larry  
Boucher/babcockpower@babcockpower  
Subject  
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\*\*\*\*\*

**From:** James Nelson  
**To:** Ken Nielson  
**Date:** 12/1/2003 3:21 PM  
**Subject:** Fwd: Re: Intermountain Power - Unit 2 OFA controls design information

I will ask Phil to do just that. Feel free to contact him also.

>>> Ken Nielson 12/1/2003 3:20:22 PM >>>

James,

Thanks for the update. Could you copy the linkage/motor drive drawings to me? I am trying to get the controls portion of the design & construction packages completed and it would be helpful to verify that there are no surprises at my end in terms of where I need to place cabinets, run conduit, and locate instrument panels and instrumentation.

Thanks,

Ken N.

>>> James Nelson 12/1/2003 2:51:33 PM >>>

Ken, thanks for keeping this issue in the forefront. I recently received a set of drawings from BPI that I believe addresses the linkage design issues. Phil is currently reviewing them. -FYI

>>> Ken Nielson 12/1/2003 9:32:12 AM >>>

FYI:

Babcock does intend to move the OFA linkage external for U2. Following our conversations on that issue, I went through the information that I have received from Babcock Power on the U2 design to see if they had indicated anything in writing (including e-mail) or had just indicated it verbally. The e-mail below does indicate that Babcock does intend to bring the linkage external to the OFA ducts for U2. I have requested design drawings on this via phone conversation, voice mail, and e-mail, but as yet have not received them. We need to get these soon if we are to have any review prior to Babcock going to production on the components.

Ken N.

>>> <[fpalacios@babcockpower.com](mailto:fpalacios@babcockpower.com)> 10/1/2003 12:01:43 PM >>>

Ken: This is an attempt to answer your questions. I am only starting this project now and don't have all the answers as yet. However the following is offered:

1. My understanding is that Unit 2 is a duplicate and therefore the recommended controls will remain the same as for Unit 1.
2. Are you referring to position transmitters or a local mechanical position indicator? I take it you mean a local indicator. This option may require a change order, depending on how we priced the units. I'll discuss it with Larry Boucher.
3. A quick check revealed that we intend to design external linkages. We don't know as yet how this will affect the relative location of the drives. I'll follow up on this.
4. I don't expect any logic changes.

"Ken Nielson"  
<KENNETH-N@ipsc.com>  
To  
<fpalacios@bbpwr.com>  
09/30/2003 02:46 PM cc  
"Phil Hailes" <Phil-H@ipsc.com>  
Subject  
Intermountain Power - Unit 2 OFA  
controls design information

Francisco,

I am currently assembling the construction package for the controls to be installed with the OFA system on Unit 2. In this process a few questions have come up on the U2 installation. I have listed those below.

- 1) Will there be any changes to the OFA controls and instrumentation design for Unit 2?
- 2) Are the same quantity and type (Jordan series 5200) of drives to be installed? Also the 5200s that were installed to replace the 5100s on the 1/3 drives on unit 1 included a position indication. IPSC would like this as well for all unit 2 drives.
- 3) During our discussions with Larry Boucher following the installation of the Unit 1 OFA system, Larry indicated that BPI was looking at moving the damper control linkage outside of the OFA ducts. Does the OFA design for U2 move the linkage outside the ducts? If so, will the location of the drives remain approximately the same?
- 4) Will there be any logic changes on the OFA controls design for U2?

Thank you in advance for this information.

Sincerely,

Ken Nielson

Kenneth M. Nielson, P.E.  
Lead Engineer, Technical Services  
Intermountain Power  
Delta, UT 84624  
Phone: (435) 864-6437  
Fax: (435) 864-0737  
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\*\*\*\*\*

**From:** James Nelson  
**To:** Aaron Nissen; Jerry Hintze; Jon Christensen; Ken Nielson; Phil Hailes  
**Date:** 12/1/2003 2:51 PM  
**Subject:** Fwd: Re: Intermountain Power - Unit 2 OFA controls design information

Ken, thanks for keeping this issue in the forefront. I recently received a set of drawings from BPI that I believe addresses the linkage design issues. Phil is currently reviewing them. -FYI

>>> Ken Nielson 12/1/2003 9:32:12 AM >>>

FYI:

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>>> <[fpalacios@babcockpower.com](mailto:fpalacios@babcockpower.com)> 10/1/2003 12:01:43 PM >>>

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"Ken Nielson"  
<[KENNETH-N@ipsc.com](mailto:KENNETH-N@ipsc.com)>  
09/30/2003 02:46 PM  
To  
<[fpalacios@bbpwr.com](mailto:fpalacios@bbpwr.com)>  
cc  
"Phil Hailes" <[Phil-H@ipsc.com](mailto:Phil-H@ipsc.com)>  
Subject  
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Thank you in advance for this information.

Sincerely,

Ken Nielson

Kenneth M. Nielson, P.E.  
Lead Engineer, Technical Services  
Intermountain Power  
Delta, UT 84624  
Phone: (435) 864-6437  
Fax: (435) 864-0737  
[kenneth-n@ipsc.com](mailto:kenneth-n@ipsc.com)

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IP7\_039973

**From:** Ken Nielson  
**To:** James Nelson  
**Date:** 12/1/2003 3:20 PM  
**Subject:** Fwd: Re: Intermountain Power - Unit 2 OFA controls design information

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Ken N.

>>> <[fpalacios@babcockpower.com](mailto:fpalacios@babcockpower.com)> 10/1/2003 12:01:43 PM >>>

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4. I don't expect any logic changes.

"Ken Nielson"  
<KENNETH-N@ipsc.  
com>

To

<fpalacios@bbpwr.com>  
09/30/2003 02:46 cc  
PM "Phil Hailes" <Phil-H@ipsc.com>  
Subject  
Intermountain Power - Unit 2 OFA  
controls design information

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- 4) Will there be any logic changes on the OFA controls design for U2?

Thank you in advance for this information.

Sincerely,

Ken Nielson

Kenneth M. Nielson, P.E.  
Lead Engineer, Technical Services  
Intermountain Power  
Delta, UT 84624  
Phone: (435) 864-6437  
Fax: (435) 864-0737  
[kenneth-n@ipsc.com](mailto:kenneth-n@ipsc.com)

\*\*\*\*\*

IP7\_039975

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**From:** James Nelson  
**To:** Ken Nielson  
**Date:** 12/30/2002 3:41 PM  
**Subject:** Fwd: Re: Intermountain Power- 100210- Control Description  
**Attachments:** Re: Intermountain Power- 100210- Control Description

Did you receive this also?

IP7\_039977

**From:** Jerry Finlinson  
**To:** Ken Nielson  
**Date:** 3/1/2003 5:51 AM  
**Subject:** Fwd: RE: IPSC requests electronic dwgs.  
**Attachments:** IPSC.zip

Jerry Finlinson, Engineer  
Intermountain Power Service Corp  
850 West Brush Wellman Rd  
Delta, UT 84624  
435-864-6466 fax 0776/6670  
jerry-f@ipsc.com

>>> Andy Chew <[achew@airmonitor.com](mailto:achew@airmonitor.com)> 02/28/03 05:19PM >>>  
Jerry,

Here are the CAD files requested for both AMC WO's 47358 and 47791.

Regards,

Andy  
Air Monitor Corp

-----Original Message-----

From: Jerry Finlinson [<mailto:Jerry-F@ipsc.com>]  
Sent: Thursday, February 27, 2003 11:54 AM  
To: Andy Chew; Dan Beistel  
Cc: Ken Nielson  
Subject: IPSC requests electronic dwgs.

Andy and Dan,

We are trying to finish up our drawing packages for the air flow systems on  
Primary Air Flow AMC work order 47358  
Overfire Air AMC work order 47791

We want to include some of your drawings from the submittal package as reference drawings and would appreciate an electronic copy to save our on drawing server for the techs to reference, as specified in our specifications. Preferably, autocad format.

Thanks, Jerry

PS. on AMC work order 47358, I made a mistake on the duct measurements. Instead of 22"H x 68"W, it is 22"H x 66"W, which changes the range slightly to 6.801 from 6.4. Please update your records.

Jerry Finlinson, Engineer  
Intermountain Power Service Corp  
850 West Brush Wellman Rd  
Delta, UT 84624

IP7\_039978

435-864-6466  
[jerry-f@ipsc.com](mailto:jerry-f@ipsc.com)

fax 0776/6670

**IP7\_039979**

**From:** Ken Nielson  
**To:** Bill Morgan; James Nelson; Phil Hailes  
**Date:** 4/16/2003 5:30 PM  
**Subject:** Fwd: Re: Jordan Drive Requirements for Intermountain Power OFA Dampers  
**Attachments:** Re: Jordan Drive Requirements for Intermountain Power OFA Dampers

Kenneth:

In accordance with your request and our walk through and discussion, we submit the following scope of work and pricing for your review.

1. Install 8" x 8" Nema 12 Hoffman wireway, three (3) locations on level 8 & 9 at the Over-fire Air / boiler areas. GSL will adequately support and tie these sections of wireway between Unit 2 cable trays.
2. GSL will have Mallory Engineering Company custom make three (3) transitional sections to fit between the column and the toe kick area. This transitional pieces will reduce from 8" to 5" and then back to 8" at the column areas.
3. This price includes all labor, material & equipment to complete this project in a timely manner.

**TOTAL PRICE:        \$24,180.00**

Thank You,

Craig Mullen

**IP7\_039981**

Kenneth:

In accordance with your request, we submit the following pricing breakdown for your review.

Material and tax: \$12,898.00 includes 10% mark-up. Also includes complete bill of material for Nema 12 wireway, all wireway supports and three (3), 8" x 8" transitional pieces (fabricated by Mallory Engineering).

Labor: 239 hrs. @ an average labor rate of \$35.50/hr. with a 15% mark-up. \$9,758.00.

Job equipment & expense: \$1,524.00

**TOTAL PRICE: \$24,180.00**

These hourly rates and material & equipment mark-ups are in accordance with our time & material contract agreement. If you have any questions about this quote, please feel free to contact me.

Thank You,

Craig Mullen  
Project Manager

**IP7\_039982**

**From:** Ken Nielson  
**To:** Mike Nuttall  
**Date:** 1/27/2004 9:26 AM  
**Subject:** GSL contract work for OFA.

Mike,

You were copied some cost and budget information from GSL. The go ahead was given to GSL to begin ordering materials and start work on that project. I need to get with you and see ensure sufficient funds have been allocated to your contract from OFA project for the GSL work.

Thanks,  
Ken N.

IP7\_039983

## Intermountain Generating Station Boiler Over-Fire Air (OFA) Installation Project

### Description & Control Outline

#### Description of the Overfire Air (OFA) System and Control Devices.

The over-fire air (OFA) system at the Intermountain Generating Station (IGS) is being provided by Babcock Power, Inc. (BPI). It consists of a single row of OFA ports located on the elevation immediately above the top burner levels on the front (south) and rear (north) sides of the boiler. Each row consists of eight, identical, OFA ports with one port located over each of the six burner columns (column ports) and one port located on each end of the OFA rows near the side walls of the boiler (wing ports). OFA rows are divided into halves that include one wing port and the next three column ports. Each half has a separate OFA header duct.

Air to the OFA system is provided by the Secondary Air (SA) system. A feeder duct extends from each SA header duct to the corresponding OFA header through which secondary air is admitted to the OFA headers. Each OFA feeder duct includes an isolation damper operated Jordan rotary electrical drive.

OFA airflow to the boiler is admitted and controlled through the OFA port dampers. Each OFA port is partitioned into separate 1/3 and 2/3 sections with the 1/3 partition located above the 2/3 partition. Airflow through each partition is controlled by a separate port damper located in each partition. The four, 1/3 port dampers for an OFA row half are connected or ganged together for simultaneous operation by a Jordan rotary electrical drive. The same configuration is implemented for the 2/3 port damper sets. This creates a total of four, 1/3 port dampers/drives and four, 2/3 port dampers/drives for air flow control to the boiler.

Control and monitoring of all OFA damper drives will be done by the IGS combustion control system. Additionally, an array of three Air Monitor Corporation VOLU-probes and thermocouples will measure OFA mass flow through each of the feeder ducts

#### Description of the Proposed Control Strategy.

Note: All boiler load setpoint values and OFA to secondary air ratio setpoint curve, described below, are initial values. These values will be revised based on the results of the commissioning performance tests. Please refer to documentation to be provided by BPI.

OFA will be used to control NO<sub>x</sub> formation at unit loads above approximately 60% of the rated load of 950 MW. At the 60% load point and above, OFA flow will be accomplished by the combination of opening OFA feeder and port dampers and decreasing the combustion air damper positions so as to maintain target total SA flow based on unit load.

The OFA port and feeder duct dampers are not modulating and will be operated either fully open or fully closed (except for biasing of the open position to achieve balance O<sub>2</sub> or NO<sub>x</sub> distribution on the back end of the boiler). The OFA feeder duct dampers are to

be used to balance flow from side to side of the OFA system. OFA port dampers are to be used to control proper airflow to the boiler

Simultaneous forcing SA airflow to the OFA system is attained by simultaneously and identically decreasing the opening of all the combustion air dampers feeding each of the burner elevations in operation. This decrease is to be superimposed on the existing automatic control biasing of each elevation combustion air in accordance with its pulverizer load.

This SA damper control is additive to the existing bias required to change burner airflow in proportion to the individual pulverizer load. The action of the sum of both biases will result in less secondary air directly to the burners, as OFA is being introduced, but the relative secondary air distribution between burner elevations will remain unchanged.

BPI will provide a setpoint curve showing the desired ratio of OFA flow to secondary airflow as a function of boiler load. These values will be confirmed or revised by actual tests.

The OFA port relative open area sizes, 1/3 and 2/3, are calculated to provide the correct velocity of the OFA to attain the proper penetration of the OFA into the combustion region of the furnace above the burners. All ports of a given kind, 1/3 or 2/3, will open or close following a program designed to open the correct area to roughly produce the proper penetration velocity as the OFA air flow rate changes with boiler load. The initial program is as follows:

0 to 60% boiler load:	All 1/3 and 2/3 ports closed
60 to 75% boiler load:	1/3 ports open, 2/3 ports closed
75 to 90% boiler load:	1/3 ports closed, 2/3 ports open
90 to 100% boiler load:	1/3 ports open, 2/3 ports open

An individual manual/automatic and bias station per port group damper drive will be provided.

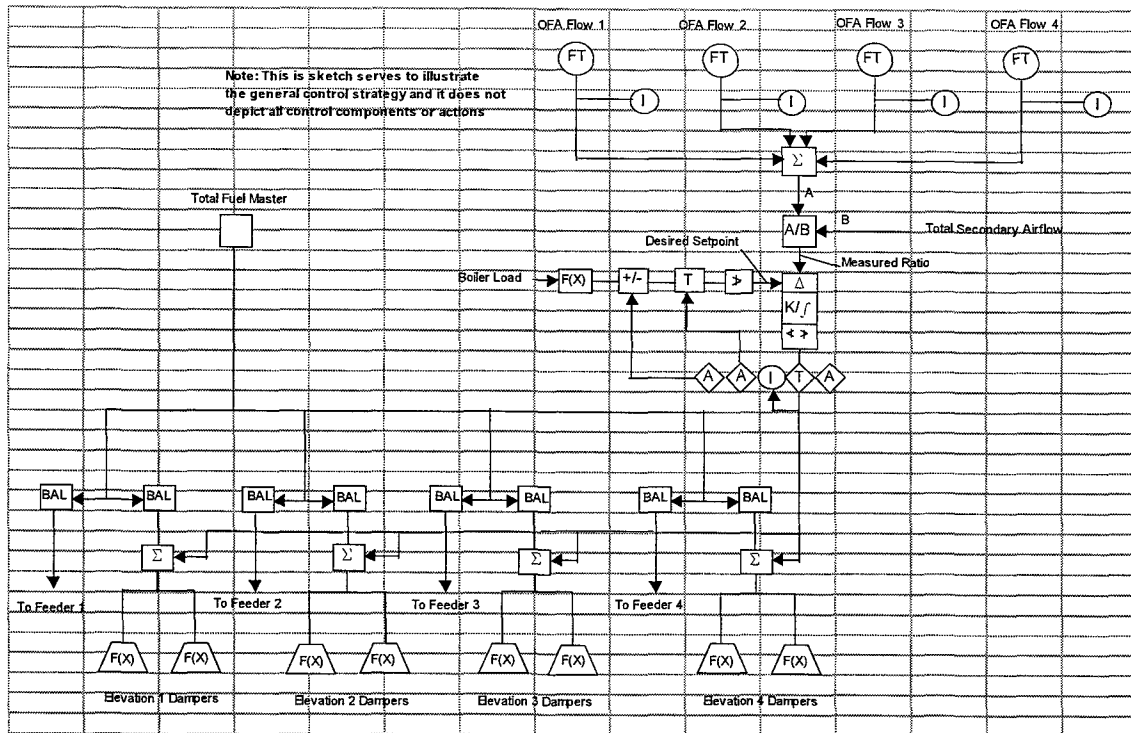


Fig 1

Unit 2 - Over Fire Air Equipment - Tagging List							
Item	Description	Project ID	Elev./ Column & Row	Model, Size, or Diameter	Breaker Location/ Power Source	Normal Position	De-energ ized position
1.	SW OFA Header Inlet Dmpr Drive	2SGB-CDR-0169	4803'	Jordan 5220	2APA-PPL-009 BRKR 24	Closed	Open
2.	SE OFA Header Inlet Dmpr Drive	2SGB-CDR-0170	4803'	Jordan 5220	2APA-PPL-009 BRKR 30	Closed	Open
3.	NW OFA Header Inlet Dmpr Drive	2SGB-CDR-0171	4803'	Jordan 5220	2APA-PPL-008 BRKR 17	Closed	Open
4.	NE OFA Header Inlet Dmpr Drive	2SGB-CDR-0172	4803'	Jordan 5220	2APA-PPL-008 BRKR 27	Closed	Open
5.	SW OFA 2/3 Dmpr Drive	2SGB-CDR-0173	4803'	Jordan 5220	2APA-PPL-009 BRKR 26	Closed	Open
6.	SE OFA 2/3 Dmpr Drive	2SGB-CDR-0174	4803'	Jordan 5220	2APA-PPL-009 BRKR 32	Closed	Open
7.	NW OFA 2/3 Dmpr Drive	2SGB-CDR-0175	4803'	Jordan 5220	2APA-PPL-008 BRKR 19	Closed	Open
8.	NE OFA 2/3 Dmpr Drive	2SGB-CDR-0176	4803'	Jordan 5220	2APA-PPL-008 BRKR 29	Closed	Open
9.	SW OFA 1/3 Dmpr Drive	2SGB-CDR-0177	4803'	Jordan 5220	2APA-PPL-009 BRKR 28	Closed	Open
10.	SE OFA 1/3 Dmpr Drive	2SGB-CDR-0178	4803'	Jordan 5220	2APA-PPL-009 BRKR 34	Closed	Open
11.	NW OFA 1/3 Dmpr Drive	2SGB-CDR-0179	4803'	Jordan 5220	2APA-PPL-008 BRKR 25	Closed	Open
12.	NE OFA 1/3 Dmpr Drive	2SGB-CDR-0180	4803'	Jordan 5220	2APA-PPL-008 BRKR 31	Closed	Open
13.	OFA Hdr SW Inlet Flow CAMS CAB	2SGB-CAB-0011	4803'	Air Monitor CAMS	2APA-PPL-008 BRKR 33	Closed	Open
14.	OFA Hdr SE Inlet Flow CAMS CAB	2SGB-CAB-0012	4803'	Air Monitor CAMS	2APA-PPL-009 BRKR 36	Closed	Open
15.	OFA Hdr NW Inlet Flow CAMS CAB	2SGB-CAB-0013	4803'	Air Monitor CAMS	2APA-PPL-008 BRKR 35	Closed	Open
16.	OFA Hdr NE Inlet Flow CAMS CAB	2SGB-CAB-0014	4803'	Air Monitor CAMS	2APA-PPL-009 BRKR 38	Closed	Open

\* Need clearance on PPL-008 and PPL-009 listed above, or OK\_To, to connect wiring.

\*\* Following wiring connection, need clearance or OK\_To on breakers to allow for connection to amplifiers and drives.

**Instruction Manual**

IM-0422

**Jordan**  
**CONTROLS****SM-5100 Series Rotary Actuator****Table of Contents**

General Information .....	2-3
Introduction .....	2
Cautions .....	2
Receiving/Inspection .....	2
Storage .....	2
Equipment Return .....	2
Identification Label.....	3
Abbreviations Used in This Manual .....	3
General Actuator Description .....	3
Basic Models .....	3
Specifications .....	4-5
Actuator .....	4
Options .....	5
Installation .....	5-6
Typical Wiring Diagrams .....	7-8
Start Up .....	8-10
Troubleshooting .....	11-12
Parts Identification .....	13-15
Maintenance .....	16-17
Major Dimensions .....	18-19
Linkage Options .....	18
Actuator .....	19

**Failure to properly wire torque/thrust switches will result in actuator damage.***Refer to the specific wiring diagram supplied with your actuator for correct wiring.*

*Due to wide variations in the terminal numbering of actuator products, actual wiring of this device should follow the print supplied with the unit.*

## GENERAL INFORMATION

### INTRODUCTION

Jordan Controls, Inc., designs, manufactures, and tests its products to meet national and international standards. For these products to operate within their normal specifications, they must be properly installed and maintained. The following instructions must be followed and integrated with your safety program when installing, using, and maintaining Jordan Controls products:

Read and save all instructions prior to installing, operating, and servicing this product.

If any of the instructions are not understood, contact your Jordan Controls representative for clarification.

Follow all warnings, cautions, and instructions marked on, and supplied with, the product.

Inform and educate personnel in the proper installation, operation, and maintenance of the product.

Install equipment as specified in Jordan Controls installation instructions and per applicable local and national codes. Connect all products to the proper electrical sources.

To ensure proper performance, use qualified personnel to install, operate, update, tune, and maintain the product.

When replacement parts are required, ensure that the qualified service technician uses replacement parts specified by Jordan Controls. Substitutions may result in fire, electrical shock, other hazards, or improper equipment operation.

Keep all actuator protective covers in place (except when installing, or when maintenance is being performed by qualified personnel), to prevent electrical shock, personal injury, or damage to the actuator.

### WARNING

Before installing the actuator, make sure that it is suitable for the intended application. If you are unsure of the suitability of this equipment for your installation, consult Jordan Controls prior to proceeding.

### WARNING - SHOCK HAZARD

Installation and servicing must be performed only by qualified personnel.

### WARNING - ELECTROSTATIC DISCHARGE

This electronic control is static-sensitive. To protect the internal components from damage caused by static discharge, never touch the printed circuit cards without being statically protected.

### RECEIVING INSPECTION

Carefully inspect for shipping damage. Damage to the shipping carton is usually a good indication that it has received rough handling. Report all damage immediately to the freight carrier and Jordan Controls, Inc.

Verify that the items on the packing list or bill of lading agree with your own.

### STORAGE

If the actuator will not be installed immediately, it should be stored indoors in a clean, dry area where the ambient temperature is not less than -20° F. The actuator should be stored in a non-corrosive environment. The actuator is not sealed to NEMA 4 until the conduit entries are properly connected.

### EQUIPMENT RETURN

A Returned Goods authorization (RG) number is required to return any equipment for repair. This must be obtained from Jordan Controls. (Telephone: 414/461-9200) The equipment must be shipped, freight prepaid, to the following address after the RG number is issued:

Jordan Controls, Inc.  
5607 West Douglas Avenue  
Milwaukee, Wisconsin 53218  
Attn: Service Department

To facilitate quick return and handling of your equipment, include:

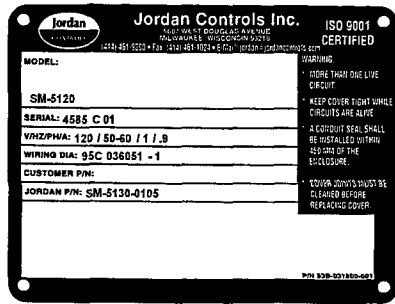
RG Number on outside of box  
Your Company Name, Contact Person, Phone/Fax #  
Address  
Repair Purchase Order Number  
Brief description of the problem

## GENERAL INFORMATION

### IDENTIFICATION LABEL

An identification label is attached to each actuator cover. The serial number is also stamped on the aluminum housing, directly above the conduit entry. When ordering parts, requesting information or service assistance, please provide all of the label information.

EXAMPLE:



MODEL NUMBER: SM-5130 Series

SERIAL NUMBER: 4585 C 01  
 Sequential Number— Year Built  
 Month Built

### GENERAL DESCRIPTION, ACTUATOR

The SM-5000 Series are quarter turn, rotary actuators that produce up to 12,500 ft. lbs. (16,947 Nm) of torque, and offer continuous modulating duty up to 4,000 starts per hour. They are designed for up to 90° rotation with bi-directional torque overload protection and have a manual override handcrank. This series of actuators uses a scotch-yoke output gearing design that provides up to 66% more torque at the ends of travel (0° and 90° positions). The SM-5000 Series is ideally suited for dampers, vanes and valve control requiring high torque and exact position control.

All SM-5000 Series actuators are also available with an internal amplifier (excluding SM-5140). These amplifiers are all full-featured ac or dc switching devices designed to seamlessly work with the actuator for closed loop control.

The SM-5100 series includes 120/240 Vac single phase models, 208/240/380/480 Vac three phase models, and 24 and 90 Vdc models. Up to six independently adjustable position limit switches are available as options.

### ABBREVIATIONS USED IN THIS MANUAL

A	.....	Ampere
AC	.....	Alternating Current
° C	.....	Degrees Celsius
CW	.....	Clockwise
CCW	.....	Counterclockwise
DC	.....	Direct Current
° F	.....	Degrees Fahrenheit
G	.....	Earth Ground
Hz	.....	Hertz
in. lbs.	.....	Inch Pounds
kg	.....	Kilogram
L	.....	Line (power supply)
lbs.	.....	Pounds Force
LVDT	.....	Linear Variable Differential Transformer
mA	.....	Milliamp
mfd	.....	Microfarad
mm	.....	Millimeters
N	.....	Newton (force)
NEMA	.....	National Electrical Manufacturing Association
Nm	.....	Newton Meter
NPT	.....	National Pipe Thread
PH	.....	Phase
PL	.....	Position Limit Switch
RPM	.....	Revolutions per Minute
SEC	.....	Second
TL	.....	Torque Limit Switch
V	.....	Volts
VA	.....	Volt Amps
Vac	.....	Volts ac
Vdc	.....	Volts dc
VR	.....	Variable Resistance
W	.....	Watt

### BASIC MODELS

The **SM-5120** and **SM-5190** are single phase ac, three wire, plug reversible models.

These models may also be equipped with an internal AD-8130 servo amplifier that features loss of signal detection for current command signal inputs and can be calibrated to allow the actuator to lock-in-place or drive to a preset position should the command signal drop below 3.8mA. Also included is a dynamic brake circuit to increase positioning accuracy and a loop-powered, 4 to 20mA position transmitter.

The **SM-5115** is a three phase ac, reversible model, and can be equipped with an internal AD-8900 series servo amplifier.

The **SM-5140** and **SM-5160** are dc proportional control models. These actuators may be equipped with an internal AD-7830 or AD-9120 servo amplifier, or external AD-7830, AD-9120 or AD-7540 servo amplifier.

## SM-5100 Series Specifications

**Rotation:** Up to 90°

**Duty Cycle:** AC: 2,000 1% position changes/hour.  
DC: 4,000 1% position changes/hour.

**Temperature:** -40°F to 150°F (-40°C to 65°C).

**Environment Ratings:** NEMA Type 4 (IP65) or Explosion Proof, Class I, Division 1, Groups C & D. Class II, Division 1, Groups E, F & G.

**Weight:** Approximately 80 lbs. (36 kg).

**Enclosure Materials:** Cast aluminum alloy.

**Lubrication Type:** Grease, permanently lubricated.

**Gearing:** Spur type.

**Hold on Loss of Power:** Self-locking. Optional brake allows improved positioning response.

**Mounting:** Any position.

**Torque Limiting:** Bi-Directional, disables motor in one direction when torque rating is exceeded.

**Output Shaft:** One inch (25.4mm) diameter with 20 tooth spline, or one inch (25.4mm) diameter with 0.25 inch square (6.35 mm) keyway.

**Anti-Condensation Heater:** 120 or 240 Vac, 30 Watt with thermostat set for 110°F (43.3°C).

**Position Feedback:** 1000 ohm potentiometer. Optional contactless feedback available.

**Field Wiring:** To barrier type terminal blocks.

**Integral Thermal Protection/Single Phase AC Motor:** Standard thermal overload protection at 130°C, self resetting.

**End-of-Travel Position Limit Switches:** 20 amp, 250 Vac

Actuator Model	Input Power Volts/Phase/Hz	Current (Amps)		Amplifier Model		*Time/Torque sec./ft. lbs. (Nm)
		Run	Stall	Internal	Remote	
SM-5115	240/3/50-60	0.4	1.3	AD-8900	AD-8900	16/150 (203)
	380/3/50	0.3	0.9			29/300 (407)
	480/3/50-60	0.2	0.65			48/300 (407)
SM-5120	120/1/50-60	2.5	2.9	AD-8130	AD-8230	16/150 (203) 29/300 (407) 48/300 (407)
SM-5140	24 Vdc	4.5	10	NA	AD-7540	20/150 (203) 33/300 (407)
SM-5160	90 Vdc	2.5	6	NA	AD-7830 or AD-9120	13/150 (203) 24/300 (407) 39/300 (407)
	120/1/50-60			AD-7830 or AD-9120	NA	
	208/1/50-60					
	240/1/50-60					
SM-5190	240/1/50-60	1.2	1.5	AD-8130	AD-8230	16/150 (203) 29/300 (407) 48/300 (407)

\*Multiply these shift times by 1.2 for 50 Hz operation of AC models. All travel times are nominal for 90° of movement.

### OPTION SPECIFICATIONS

**Servo Amplifiers:** All servo amplifiers include a field-adjustable command signal monitor that can be set for lock-in-place, or drive to a pre-set position if the current command signal is lost. They also have a dynamic brake circuit which helps increase positioning accuracy of the loop by minimizing motor coast. These amplifiers are also equipped with a 4-20mA isolated two wire, loop-powered transmitter.

**Local Auto/Manual, INC/OFF/DEC Toggle Switches:** Actuator-mounted switches for control of Auto/Manual and INCREASE/OFF/DECREASE. These are available as toggle switches or NEMA style rotary switches.

**Output Shaft:** One inch (25.4mm) diameter with 0.25 inch square (6.35 mm) keyway.

**20 Tooth Splined Drive Arm:** Reversible for ½ tooth positioning.

**Linkage Kit:** Includes two clevises, two adjustment rods with lock nuts, two pipe adapters, two pins for clevises.

**Auxiliary Position Limit Switches:** (two or four): 20 amps, 250 Vac maximum, or 5 amps at 28 Vdc.

**Transmitter Position Feedback:** 4 to 20mA, isolated two wire loop-powered type. Tracks actuator position. Requires separate power.

**Local Position Indicator:** Reversible indicator to show open or close in either direction.

**Local Control:** Actuator mounted NEMA 4 rated switches for control of AUTO/MANUAL and INCREASE/OFF/DECREASE. These are available as toggle switches or NEMA-style rotary switches.

**LVDT Contactless Feedback:** Characterized feedback assembly directly replaces the standard linear feedback potentiometer.

## Installation

### MOUNTING

The outline and mounting dimensions for a standard unit are shown on page 23 of this manual. The rear cover opposite output shaft must have clearance so that it may be removed for adjustments and interconnect wiring. When the actuator is directly coupled to a drive shaft, it is recommended that a flexible, no backlash type coupling be used. The output shaft is also available with a splined output for standard lever arms and linkage drive to the driven load. The unit may be mounted on the standard foot mount, or a flange mount. Mounting may be in any position convenient to the driven load.

When mounting the unit, be sure that no excessive axial or side loading is applied to the output shaft. The limit switches and position feedback are connected through gearing to the output shaft of the actuator which should be positively secured to the driven load shaft so that no slippage can occur which would cause misalignment or damage.

When manual override is required, as in the event of a power failure, turn the crank in the proper direction for the desired output shaft rotation. If during manual operation, electric power is applied to the actuator,

the selector lever will return to the "auto" position and the actuator will respond to the power command. The shift from "manual" to "auto" disengages the manual crank, which cannot be power driven, thereby protecting the operator.

Care, however, should be taken when driving a load to recognize that excessive output torque may be developed by forcing the handcrank. A mechanical telltail-indicator shaft adjacent to the crank indicates over-torquing. The telltail-indicator shaft will either protrude or recede depending on the direction of over-torquing. Discontinue cranking on over-torque warning.

The motor, limit switch and feedback area of the actuator depends upon the cover to maintain the NEMA 4 rating. This cover should be removed only when actual work is being done in that area and reinstalled immediately thereafter.

This actuator contains internal mechanical stops. If it is allowed to run outside of the initial factory alignment of the limit switches, a realignment of switches and feedback might be required.

## Installation

### INSTALLATION WIRING

Typical wiring diagrams are shown on pages 7-8. **Actual wiring should follow the print supplied with the actuator.**

The wiring diagram shows the fundamental connections for the standard three-wire reversible single-phase motor, and the standard permanent magnet dc motor. These units show an arrangement with torque switches, four limit switches, two feedback potentiometers, and a heater. To meet special requirements, certain items shown may not be supplied. **In all instances the wiring diagram appropriate to the equipment will be supplied with each unit.**

A barrier type terminal strip is located under the rear cover opposite the output shaft. Two conduit entries are located in the side of the unit to accommodate standard 1 inch N.P.T. fittings.

**CAUTION:** On standard single-phase wiring, the position limit switches and the torque switches are wired directly in the motor circuit and protect it at the extremes of travel or at torque cutout. Three phase AC or DC units must have these torque and position limit switches wired into the controlling device to cause end of travel or torque shutdown. Care must be taken in wiring these to the controlling device so that the appropriate direction of control is turned off when that direction's limit switch is actuated. If care is not taken in phasing the equipment, damage may occur to the actuator or driven load. Also, inductive devices, such as lights and solenoids, must not be paralleled across motor terminals 1 and 2 or 1 and 3 as this will upset the motor capacitor phase shift and motor torque will be affected.

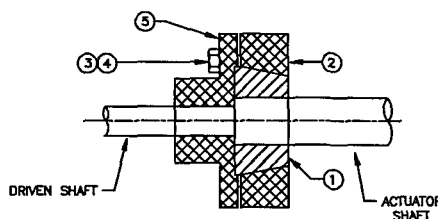
- All wiring must be done in accordance with prevailing codes by qualified personnel.
- Fusing must be installed in line power, and should be of the slow blow type.
- Wiring should be routed to the actuator through the two conduit openings. Generally, one conduit will contain input power and earth ground wires. The other conduit would then contain low level input and output signal wiring. It is required that all low level signal wiring be a shielded type with the shield grounded at source common.
- After installation, it is required that all conduits be sealed to prevent water damage and to maintain NEMA 4 enclosure and applicable dust ignition ratings.

### JORDAN CONTROLS SUPPLIED (OPTIONAL) COUPLING (Field Installed)

Jordan Controls has designed a three piece "wedge-lock" coupling which can be adjusted to align the driven device to the actuator output shaft with no concern as to keyway alignment of the shaft on the drive device in relation to the spline on the actuator output shaft.

#### ADJUSTMENT

1. Slide coupling (5) onto driven shaft.
2. Slide coupling cone (1) and cup (2) onto actuator shaft.



3. Mount actuator with the two shafts in line and the shaft ends about inch (3 mm) apart.
4. Turn the shaft of the driven device to the close position.
5. Run the actuator to the close limit switch.
6. Lock coupling (5) to the driven shaft by pinning or other suitable method.
7. Slide cone (1) to fit flat in recess of coupling (5).
8. Install three bolts and lockwasher (3) and (4) and tighten. (20-30 ft. lbs.)
9. Operate the actuator in the open direction and back to the closed direction until the close limit switch stops the actuator.
10. If the driven shaft does not move to the exact closed position you want, loosen the three bolts and turn the driven shaft. Tighten the bolts. (20-30 ft. lbs.)

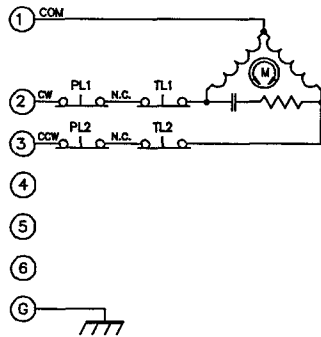
**NOTE:** Keep the coupling parts clean while assembling.

See page 18 of this manual for Jordan supplied linkage components information.

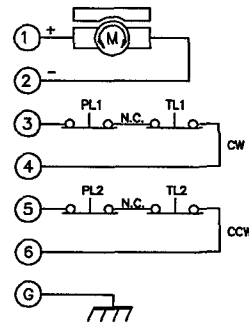
## Typical Wiring Diagrams

### ACTUATOR WITHOUT AN INTERNAL AMPLIFIER

SM-5120 (120 Vac)  
SM-5190 (240 Vac)



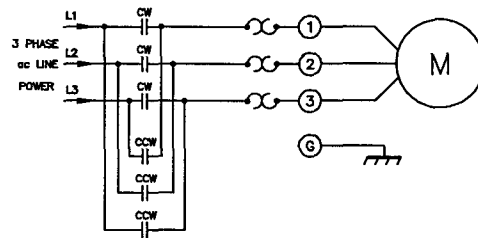
SM-5140 & SM-5160 (24 & 90 Vdc)



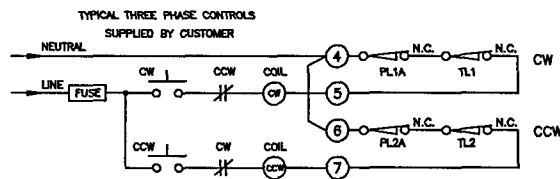
Actuator Action	AC Power Applied to Terminals		DC Power Applied to Terminals	
	1 & 2	1 & 3	1(+) & 2(-)	1(-) & 2(+)
Viewing Output Shaft	CCW	CW	CW	CCW

- Notes:**
1. The torque limit switches are factory set to trip if the rating of the actuator is exceeded.
  2. Shielded wire is required for position feedback signal wiring.

### SM-5115 SERIES ACTUATOR



Due to wide variations in terminal numbering of actuator products, actual wiring should follow the print supplied with the actuator.



- Notes:**
1. Optional remote three phase reversing starter shown.
  2. Caution: Care must be taken in properly phasing position and torque limit switches with respect to clockwise and counterclockwise positioning.

## Start Up

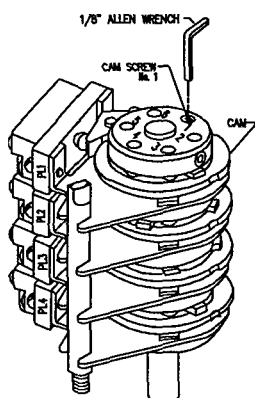
### ACTUATORS WITHOUT SERVO AMPLIFIERS

#### A. POSITION LIMIT SWITCH ADJUSTMENT (Ref. Fig. 1)

##### NOTE:

The actuator is shipped in its mid-travel position.

1. Referring to your wiring diagram, apply motor power and drive the actuator in the CW output shaft direction (looking at the shaft), until PL1 trips and stops the actuator. This is the CW limit switch setting and starting point for final switch adjustment.
2. Move the controlled equipment to the same starting point and couple the actuator output shaft to the driven shaft.
3. Apply motor power to rotate the output shaft CCW about 5 degrees, allowing PL1 switch to reset.
4. Apply motor power to rotate the output shaft CW until PL1 trips, turning off the motor. If the driven device is not at the desired position:
  - a. Remove motor power.
  - b. Using an 1/8 inch, long shaft allen wrench, loosen Cam Screw #1 about 1/4 turn.
  - c. Rotate Cam #1 CCW to allow the actuator to run further in the CW direction or rotate the cam CW to turn the actuator off sooner. (Cam #1 will turn off the motor for CW output shaft rotation, when the switch roller lever moves to the high side of the cam with the cam rotating CW.)
  - d. Position the Cam as desired and while holding in place, tighten screw #1 with moderate force to adequately clamp the cam in place.  
**DO NOT OVER TIGHTEN.**



5. Apply motor power to drive the actuator to the desired CCW position or until PL2 trips and stops the motor. If the driven device is not at the desired position:
  - a. Remove motor power.
  - b. Loosen Cam Screw #2 about a turn.
  - c. Rotate Cam #2 CW to increase the actuator's total travel range or CCW to decrease the travel range.
  - d. Hold the cam in place and tighten screw #2.
6. Electrically operate the actuator to its CW limit and back to the CCW limit to check switch settings. Readjust Cam #1 or #2 as needed.
7. Switches 3 through 6 (optional) are adjusted by loosening their respective cam screws and rotating the cam. They may be set anywhere within the range of PL1 or PL2.
8. If the unit is equipped with a feedback device and switches PL1 or PL2 were readjusted, proceed with the proper feedback alignment prior to any further adjustments or operation of the actuator.

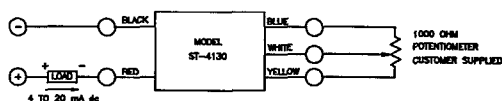
#### B. 1000 OHM POTENTIOMETER ADJUSTMENT

1. Run the actuator to the center of travel. Loosen the three panhead screws, securing the potentiometer body, and rotate it to its center of travel (500 ohm) position. An ohmmeter will be required for this adjustment. Tighten the three screws.
2. Run the actuator to the zero or minimum travel limit. With the actuator running, monitor the potentiometer with an ohmmeter to ensure the potentiometer deadband is not crossed.
3. If your system requires a low resistance starting point, loosen the three screws and rotate the potentiometer body for the required starting resistance. This is usually 20 to 50 ohms (measured from the potentiometer wiper arm to the zero end of the potentiometer).

#### C. 4 to 20mA TRANSMITTER OPTION ADJUSTMENT

The ST-4130 (1000 ohm-input, 4 to 20 mA output) two wire transmitter modulates the current on a direct current supply proportional to the input resistance. It is powered by a separate 12.0 to 36.0 Vdc regulated power supply line which is modulated from 4 to 20 mA proportional to the resistance of the input.

For the unit to function optimally, the 4mA end of the feedback potentiometer must be preset to 50 ohms.



1. Position the actuator to the desired 4mA setting.
2. With potentiometer resistance at 50 ohms, adjust ELEVATION for 4.0mA output.
3. Position the actuator to the desired 20mA setting.
4. Adjust RANGE for 20mA output.
5. Repeat steps 1 through 4 until desired accuracy is achieved.
6. To reverse the 4 and 20mA output, interchange the BLUE and YELLOW wires and return to step 1.

#### D. ACTUATOR WITH INTEGRAL AD-8130 SERVO AMPLIFIERS

Switch and feedback potentiometer alignment is accomplished in the same manner as actuator without amplifiers, except motor power is supplied from the amplifier. Varying the command signal input to the amplifier will allow reversal of the rotation of the actuator output shaft to run to the minimum/maximum switch settings. If the actuator does not run to the limit switch, but stops short, the amplifier has nulled and adjustments of span, elevation, loss of signal, or feedback potentiometer may be required. Refer to IM-0607 for information on the AD-8130 amplifier.

The EC-10852 is for use with the AD-8130 servo amplifier with LVDT (voltage feedback). The EC-10852 is used as the HI and LO trim for the AD-8130. The AD-8130 is factory set for operation with the EC-10852. **CAUTION: It is important not to adjust the HI and LO trim on the AD-8130, which are torque sealed at the factory.** For specific Setup information and calibration, refer to the wiring diagram supplied with your unit.

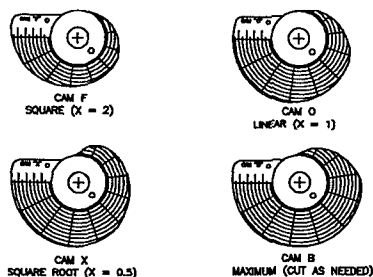
#### E. CHARACTERIZED CAM ADJUSTMENT (OPTION)

The characterized feedback assembly is an option which directly replaces the standard linear feedback potentiometer.

Prior to adjusting the cam, the end of travel limit switches must be set and the proper cam installed for your particular system requirements on the characterized cam shaft. Four different cams are supplied with each characterized assembly. The cams are printed on both sides and may be flipped over to reverse the characterization action in relation to the output shaft rotation.

The cams are each printed with a letter "O", "F", or "B" which indicate the cam type. Three of the cams are shaped to correspond to  $X=2$ , 1, and 0.5 respectively in the equation:

$$\% \text{ amplifier input} = (\% \text{ shaft rotation})x$$



The fourth cam is used for any value of  $x$  between 0.5 and 2 and must be cut by the user. For details on cutting this cam, see "To Shape Feedback Cam".

- a. Run the actuator to the zero or minimum position limit. While running, observe the direction of character cam rotation.
- b. Is the cam rotating in the direction of 100-0 for your system requirement? If not, remove the thumb screw and flip the cam over. Tighten the screw.
- c. Have you selected the proper cam for the system requirement? If not, remove the thumb screw and change the cam, installing the cam the same as in (b) above. (Green or Black side up.)
- d. Loosen three screws and remove the cam assembly.
- e. Rotate the cam until the zero on the cam is in line with the center line of the potentiometer or LVDT shaft.
- f. Potentiometers need no further adjustment.
- g. LVDT contactless feedback may require fine zeroing.
  - i. Apply power to the LVDT and monitor the output with a volt meter.
  - ii. Loosen the two body clamp screws and slide the body of the LVDT to obtain zero output.
  - iii. Tighten the body clamp screws.
  - iv. If a finer adjustment is desired, loosen the nut on the LVDT shaft and turn the shaft slightly one way or the other and tighten the nut.

#### TO SHAPE FEEDBACK CAM

With characterized feedback, one of the four cams supplied (cam B), is partially shaped. For installation, it must be cut to its final shape by the user. This cam is used if none of the other three cams produces the desired input-output relationship where:

$$\% \text{ amplifier input} = (\% \text{ shaft position})X$$

Two typical conditions where the user might want to use the fourth cam are:

1. In equation above, if the value of  $X$  is not equal to 0.5 or 2.

2. In equation, if the value of X is equal to 0.5 or 2, and if upper shaft position is not equal to 100% (90°), and/or lower shaft position is not equal to 5% (0°).

To lay out the cam shape for the desired input-output relationship, it is necessary to determine outputs (rise in cam), for various inputs (amount of cam rotation). The rise in the cam corresponds to % of maximum output range and the amount of cam rotation corresponds to % input signal to amplifier.

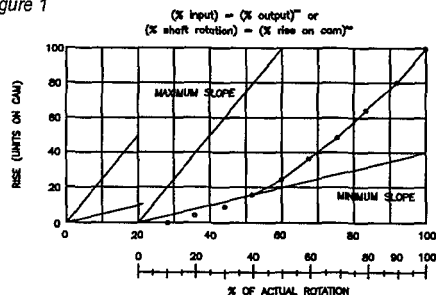
1. Lay out on graph paper, axes and maximum and minimum slopes as shown in figure 2. (Maximum slope is 25 units rise per 10% shaft rotation; minimum slope is 5 units per 10% rotation.)
2. If either upper or lower shaft position is not at 0 or 100% (0° or 90°) respectively, lay out additional x-axis scale as shown in figure 3 on page 13. Use both sets of values when plotting cam shape in step 3.
3. Calculate outputs (rise in cam) for 5% or 10% increments in input for entire input scan (actual cam rotation). NOTE: only output values that fall within maximum and minimum slope lines can be used.
4. Plot these values on cam. Scribe smooth line between points and grind cam to this shape.

Refer to example for typical cam calculations and layout.

#### TYPICAL FEEDBACK CAM CALCULATIONS

EXAMPLE: Assume X in (input/output equation) = 0.5, and that upper and lower shaft positions are at 100% and 20% (90° and 18°), same as center illustration of Figure 3.

Figure 1



Input % of actual rotation	Output	
	location on cam	% rise on cam
0	20%0	
10	28	1*
20	35	4*
30	44	9*
40	52	16
50	60	25
60	68	36
70	76	49
80	84	64
90	92	81
100	100	100

Note: These values fall outside of minimum slope on graph.

Figure 2

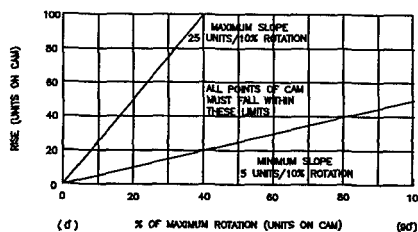
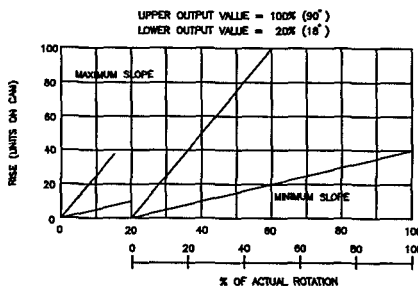
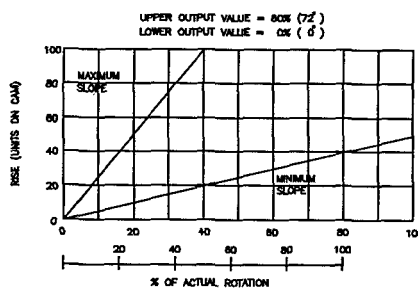
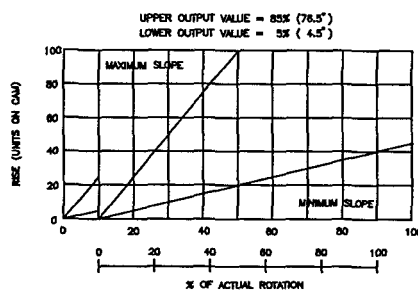


Figure 3

Illustrations below show an 80% (72°) shaft rotation span.



IF LOWER SHAFT POSITION IS NOT EQUAL TO 0% (0°)  
REDRAW SLOPE LIMITS TO GO THROUGH ACTUAL  
STARTING ROTATION POINT, AS SHOWN ABOVE.



IF LOWER SHAFT POSITION IS NOT EQUAL TO 0% (0°)  
REDRAW SLOPE LIMITS TO GO THROUGH ACTUAL  
STARTING ROTATION POINT, AS SHOWN ABOVE.